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(54) **AUTOMATED STATISTICAL SELF-CALIBRATING DETECTION AND REMOVAL OF BLEMISHES IN DIGITAL IMAGES BASED ON A DUST MAP DEVELOPED FROM ACTUAL IMAGE DATA**

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G06K 9/32 (2006.01)

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(58) **Field of Classification Search** 382/260, 382/274, 275, 282; 358/3.26, 3.27, 463
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,541,941 A 11/1970 Barr et al
3,621,136 A 11/1971 Stanwood
4,186,301 A 1/1980 Basire et al
4,364,264 A 10/1982 Kimura
4,748,509 A 5/1988 Otake et al

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1 157 344 2/2000

(Continued)

OTHER PUBLICATIONS

Patent Abstract of Japan, publication No. 2000056062, Image Input Device, publication date Feb. 18, 2000, 1 page.

(Continued)

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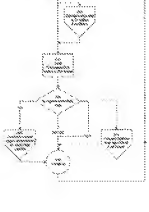
(57) **ABSTRACT**

A method of automatically correcting dust artifact regions within images acquired by a system including a digital camera includes digitally-acquiring one or more original images with the digital camera. Probabilities that certain pixels correspond to dust artifact regions within the one or more digitally-acquired images are determined. The dust artifact regions are associated with one or more extracted parameters relating to the optical system when the one or more images were acquired. A statistical dust map is formed including mapped dust regions based on the dust artifact probability determining and associating operations. Pixels corresponding to dust artifact regions within the one or more original images are corrected based on the associated statistical dust map.

82 Claims, 22 Drawing Sheets